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Assessment of the water exchange between soil and groundwater in an Alpine valley

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The soil–water balance in temperate climates can be sensitively characterised by the water exchange between soil and groundwater. Particularly in mountain environments, where the soil and the water table depth are shallow, both percolation and water rise from the water table can happen, but these latter extimate is still a major challenge for hydrological applications.

Aiming at contributing to better characterise the soil–water balance and the water exchange between soil and groundwater, at the local scale in an Alpine valley, a micrometeorological station was installed during summer 2012 at Cividate Camuno (Oglio river basin, Central Italian Alps, $274\,\mathrm{m\,a.s.l.}$), in a mountain environment with complex orography and Alpine sublitoranean climate. The soil upper layers, lying on an anthropised loose rock, are about $40\,\mathrm{cm}$ deep and mainly covered by alfalfa (*Medicago sativa*), wild carrot (*Daucus carota*) and yarrow (*Achillea millefolium*). The station is equipped with longwave and shortwave radiometers, a thermo–hygrometer, two rain–gauges, eddy correlation devices (Gill WindMaster sonic anemometer and Licor Li7500 gas analyser, sampling at $20\,\mathrm{Hz}$), a TDR with multiplexer apparatus and four probes at different depths, three soil–thermometers and a heat exchanger plate. Field and laboratory tests were performed to characterise the main soil hydraulic properties (i.e. hydraulic conductivity at saturation by means of infiltration tests and falling head permeameter, porosity, residual water content and water content at saturation, soil–water retention relationships, organic matter content and grain size distribution curve).

Three different hypothesis to model the water exchange between soil–water and groundwater were introduced. They are (i) a null exchange rate which accounts for a shortage of precipitation and for representing the underlying soil as a capillary barrier, (ii) a pure percolation with unitary gradient of the total hydraulic potential and (iii) a percolation or water rise induced by an estimate of the local gradient on the basis of the measurements of water content. As the lateral fluxes were negligible due to the site orography, accounting for the measurement of rainfall, evapotranspiration and soil–water content, the closure of the water balance allowed to assess the effectiveness of the different hypotheses to estimate the exchange between soil–water and groundwater. The results shows that the water balance is not closed without estimating the water exchange between soil and groundwater, but assessing its value was found to be strongly sensitive to the accuracy of the adopted soil model and constitutive laws.